April 30, 1935. C. I. BAKER 1,999,351

ELECTRON DISCHARGE DEVICE

Filed Oct. 23, 1931

FIG. 5

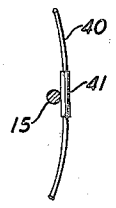


FIG. 6

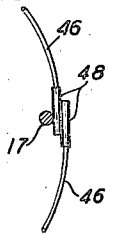


FIG. 1

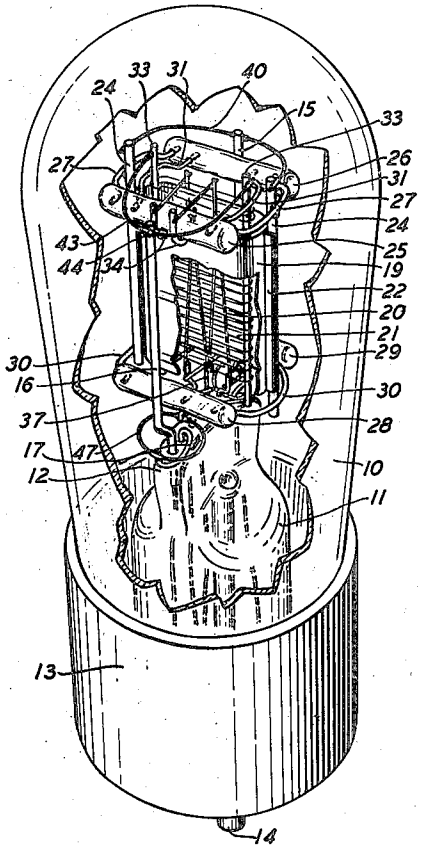


FIG. 2

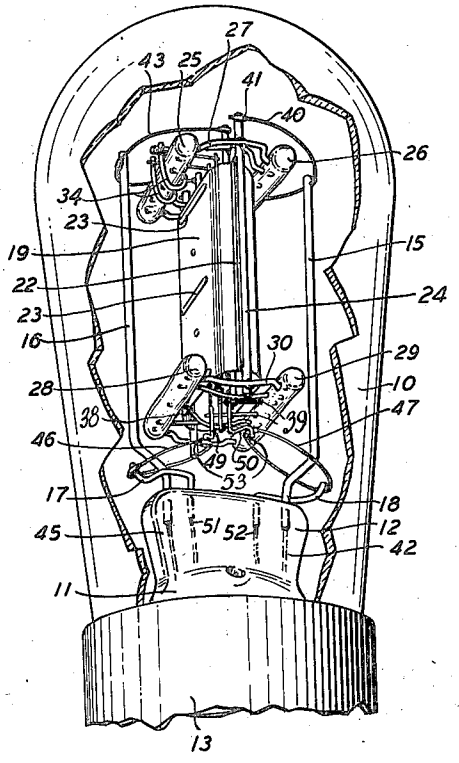
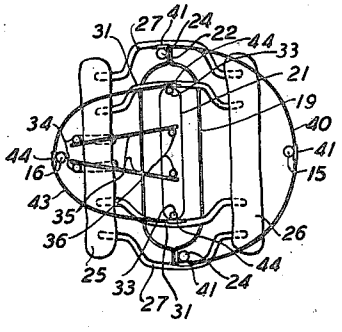


FIG. 3



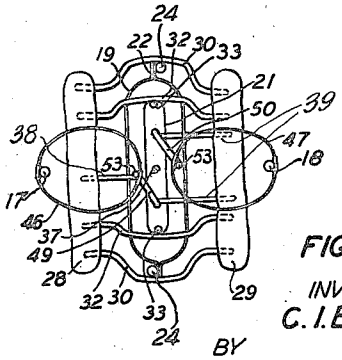


FIG. 4

INVENTOR
C. I. BAKER
BY
Walter C. Kiesel
ATTORNEY

Patented Apr. 30, 1935

1,999,351

UNITED STATES PATENT OFFICE

1,999,351

ELECTRON DISCHARGE DEVICE

Carl I. Baker, Pearl River, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application October 23, 1931, Serial No. 570,531

10 Claims. (Cl. 250—27.5)

This invention relates to electron discharge devices and more particularly to an electrode assembly in such devices.

The static and dynamic characteristics of electron discharge devices are largely dependent upon the space relation of the several electrodes. Any change in this relation, particularly such changes as are occasioned by mechanical and acoustic shocks to which the device may be subjected during operation, produce objectionable microphonic disturbances which result in unfaithful and distorted reproduction.

An object of this invention is to prevent external disturbances from affecting an electron discharge device.

Another object of this invention is to unify the electrode assembly in electron discharge devices and to facilitate the fabrication thereof.

In one embodiment of this invention an electron discharge device comprises an enclosing vessel having a stem and a unitary electrode assembly resiliently supported from the stem. The electrode assembly includes a rigid anode which supports twin insulating members at each end thereof, and a cathode and grid supported by the insulating members within the anode. A pair of uprights extend from the stem and carry spring members which are secured to the electrode assembly near one end thereof. Other spring members are mounted on supports extending from the stem and are secured to the other end of the electrode assembly. The spring members may be of electrically conductive material and may be utilized as connecting links between the electrode leading-in wires and the electrodes. Furthermore, the spring members may also be so designed by selection of the material and elasticity thereof that the electrode assembly will have a predetermined natural frequency of vibration, such as the resonant frequency of a circuit in which the device is to be utilized.

The invention will be understood more clearly and fully from the following detailed description with reference to the accompanying drawing:

Fig. 1 is a perspective view of an electron discharge device made in accordance with this invention with portions of the enclosing vessel and the anode broken away to show the inner electrode structure more clearly;

Fig. 2 is another perspective view from a different angle of the discharge device shown in Fig. 1 with a portion of the enclosing vessel broken away, showing the resilient mounting of the electrode assembly within the enclosing vessel;

Fig. 3 is an end plan view of the electrode unit assembly showing the relation of the electrodes and the supports at one end of the unit;

Fig. 4 is another end plan view of the electrode unit assembly at the opposite end of the unit; and

Figs. 5 and 6 are enlarged detail views showing the attachment of the spring members to the supports and to the electrode assembly.

Referring now to the drawing, an electron discharge device, in one embodiment of this invention, comprises an enclosing vessel 10 having a reentrant stem 11 which terminates in a substantially rectangular press 12. The vessel 10 is secured, as by cementing, to an insulating base 13 carrying terminal prongs 14 (only one of which is shown) for associating the device with an electrical circuit. A plurality of rigid rods 15 and 16 having parallel portions extending lengthwise of the vessel 10 are embedded in the press 12 and together with a plurality of bent wires 17 and 18 support a unitary electrode assembly.

The electrode assembly comprises a flattened cylindrical anode 19, and M-shaped filamentary cathode 20, and a helical control electrode or grid 21 encircling the cathode and uniformly spaced between the cathode 20 and the anode 19. The anode 19 may be of carbonized nickel or any suitable conductive material and comprises two similar plate portions having integral flanges 22 joined together, and provided with parallel spaced ridges or embossments 23 for increasing the rigidity of the anode to prevent undesirable and excessive distortion or buckling thereof due to temperature variations during the operation of the device.

A pair of metallic rods 24, which are secured to the flanges 22 of the anode, extend beyond the ends of the flanges 22 and support two unitary twin insulator assemblies. The assembly adjacent the top of the enclosing vessel 10, as shown in Fig. 3, comprises two substantially parallel insulating members 25 and 26, such as glass beads or rods. These beads are rigidly connected together and spaced apart by short wires 27 which have their ends embedded in the insulating members 25 and 26, the wires 27 being attached, for instance, by spot welding at substantially their midpoint to the metallic rods 24 adjacent one end of the anode 19. The assembly adjacent the press 12, as shown in Fig. 4, likewise comprises a pair of substantially parallel insulating members 28, 29 rigidly connected together and spaced by short wires 30 which are secured to the metallic rods 24 adjacent the other end of the anode 19. A plurality of rigid wires 31 extend between and are embedded in the insulating members 25, 26.

Similar wires 32 extend between and are embedded in the insulating members 28, 29. A pair of parallel rigid metallic rods 33 extend between and are secured to the wires 31, 32 and support the helical control electrode or grid 21 concentric with and uniformly spaced from the anode 19. A pair of wires 34 are embedded in the central section of the insulating member 25 and bent around the bead 25 to support flexible wires 35 which carry hook members 36 engaging the bights of the M-shaped cathode 20. The midpoint of the cathode 20 is engaged by a hook member 37 which is carried by a rigid wire 38 extending inwardly from the insulating member 29. The ends of the cathode 20 are secured to wire connectors 49 and 50 which are attached to wires 39, embedded in and extending from the insulating members 28. The flexible wires 35 allow longitudinal expansion and contraction of the filamentary cathode 20 with temperature variations during the operation of the device and maintain the filament taut and in the proper space relation with the grid and anode. This construction provides a compact and rigid electrode assembly which may be readily fabricated and mounted as a unit within an enclosing vessel.

In order to prevent changes in the space relation of the electrodes by acoustic or mechanical shocks and to thereby maintain the characteristics of the electron discharge device uniform, the unitary electrode assembly described above may be resiliently supported within the enclosing vessel 10 as described in detail hereinafter.

A U-shaped or bowed resilient support or spring member 40, which may be of fine tungsten wire, is secured at its ends to the rigid rods 24 and at its center to the rigid rod 15. In order to increase the surface area of the spring member and insure a rigid connection between the spring 40 and the rods 24 and 15, a sleeve 41, for example, of nickel surrounds the spring 40 at the points of contact with the rods 24 or 15 as shown in Fig. 5. This sleeve may be easily welded to the support rods without danger of weakening the fine spring member by corrosion or melting. A leading-in wire 42 is embedded in the stem 11 and electrically connects the rod 15 to one of the terminal prongs 14 so that the rod 15 and the support 40 serve as current supply connections for the anode 19.

Another bowed or U-shaped support or spring member 43, of fine tungsten wire, is secured to rod 16 and to the grid supporting rods 33 by spot welding, through metallic sleeves 44 similar to the sleeve 41. A leading-in wire 45 embedded in the stem 11 electrically connects the rod 16 to one of the terminal prongs 14 so that an electrical connection is established between the grid 21 and one of the terminals 14 through the support 43.

A pair of resilient circular or elliptical supports or spring members 46, 47 of tungsten wire, are secured to the bent wires 17, 18 respectively, for example, by spot welding through metallic sleeves 48 as shown in Fig. 6, and encircle the rigid rods 15, 16. The supports 46, 47 are similarly secured to the short wire connectors 49, 50 respectively, with the aid of nickel sleeves 53. Current is supplied to the cathode 20 through the circular or elliptical supports 46, 47 and through leading-in wires 51, 52 embedded in the stem 11 and electrically connected to the bent wires 17, 18 and to certain of the terminal prongs 14.

The resilient supports, 40, 43, 46 and 47 protect the electrode assembly against acoustic and mechanical shocks so that the electrodes are maintained in the proper space relation, microphonic disturbances are eliminated, and undistorted reproduction is realized with the device.

The resilient supports may be utilized so that the electrode assembly will have a predetermined natural frequency of vibration substantially the same as the resonant frequency of a circuit in which the device is to be employed. This is accomplished by regulating the stiffness, diameter and length of the spring members to achieve the desired result.

Although a specific embodiment of the invention is disclosed and described herein, it is to be understood that many modifications may be made in the structural assembly of the device without departing from the spirit and scope of this invention as defined in the appended claims.

What is claimed is:

1. An electron discharge device comprising an enclosing vessel having a stem, an electrode assembly including an anode, a cathode resiliently and insulatingly supported from said anode, and means supporting said assembly from said stem, said means including a resilient member secured to said anode adjacent one end of said assembly and another resilient member secured to said cathode adjacent the other end of said assembly.

2. An electron discharge device comprising an enclosing vessel having a stem, a plurality of rigid rods projecting from said stem and extending lengthwise of said enclosing vessel, a plurality of metallic connecting members in said stem, a unitary electrode assembly including an anode, a cathode and a grid mechanically coupled to and insulated from said anode, a resilient member extending from one of said rigid rods and secured to said anode at one end of said assembly, a resilient member extending from another of said rods and secured to the grid at the same end of said assembly, and a plurality of resilient members extending from said connecting members and secured to said cathode adjacent the other end of said assembly.

3. An electron discharge device in accordance with claim 2 in which the resilient members serve as current conductors for said anode, grid and cathode.

4. An electron discharge device comprising a unitary electrode assembly including an anode, a plurality of spaced insulating members supported from said anode at opposite ends thereof, a plurality of electrodes cooperatively associated with said anode, mounted between said members and supported thereby, and means mounting said assembly within said vessel, said means including a resilient member secured to said assembly adjacent one longitudinal extremity thereof, and another resilient member secured to said assembly adjacent the opposite longitudinal extremity thereof.

5. An electron discharge device comprising an enclosing vessel having a stem, a unitary electrode assembly including an anode, twin insulating members mounted on said anode at opposite ends thereof, a grid supported by said members within said anode, a filamentary cathode within said anode and grid resiliently supported between certain of said members, and means for resiliently supporting said assembly from said stem, said means including electrically independent flexible members associated with said anode, grid and cathode and serving as current conductors therefor.

6. An electron discharge device comprising an enclosing vessel having a stem, a plurality of rigid members extending from said stem, a unitary electrode assembly including an anode, a pair of insulating members mounted on said anode at each end thereof, and a cathode and a grid supported between said insulating members, resilient members adjacent one end of said assembly extending from said anode and said grid to individual rigid members, and resilient members adjacent the other end of said assembly extending between said cathode and other individual rigid members.

7. An electron discharge device in accordance with claim 6 in which the resilient members are bowed springs and serve as current conductors for said cathode, grid and anode.

8. An electron discharge device comprising an enclosing vessel having a stem, leading-in conductors embedded in said stem, an anode beyond said stem, a cathode and grid mechanically coupled to and insulated from said anode, resilient means attached to said anode and grid and connected to individual leading-in conductors, and looped resilient means attached to said cathode and other leading-in conductors and surrounding said anode and grid leading-in conductors.

9. An electron discharge device comprising an enclosing vessel having a stem, a unitary electrode assembly including an anode, sets of insulating beads positioned at opposite ends of said anode, means connecting said beads to said anode, a helical grid within said anode, supporting means extending between individual sets of beads attached to said grid, a filamentary cathode within said grid and anode, supporting means extending between one set of beads for connection to said cathode at one end of said anode, bent wires extending from an individual bead of the other set of beads, flexible connections from said wires to said cathode at the opposite end of said anode, rigid rods projecting from said stem outside the boundary of said unitary assembly, arcuate resilient springs connected to said rods and anode and grid respectively, and closed looped resilient springs connected to said cathode and stem and surrounding said rigid rods.

10. An electron discharge device in accordance with claim 9, in which metallic sleeves surround the resilient springs at the point of contact with the rigid rods.

CARL I. BAKER.